USER MANUAL

AOS AKVA Sensor Buoy

- Current, oxygen and salinity

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For a thorough introduction of Your AKVA product, we ask that all users read this entire manual. If questions occur, contact us!

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1 Safety

Safety for the user of our products, is top focus when developing new products and user manuals in AKVA group ASA.

Therefore, we strongly recommend that everyone that is using, performing repairs, service and maintenance on the product and also everyone working around the product, reads this entire manual, and especially this chapter on safety.

This recommendation is based on both personnel safety, as well the desire to keep the products in order and avoiding any damages risked if the safety instructions are not followed.

1.1 Safety symbols used in the manual

The following symbols are used in this manual:

Information

Show caution, danger of damaging equipment and mild injuries to personnel

Warning - may cause injures to personnel

Danger! Dangerous situations may occur, danger of severe personnel injuries

1.1.1 Other symbols used in this manual

Go to or see page or chapter for more or further information

1.2 Receiving new equipment

Make sure that all parts are delivered according to the service note. If the order is not complete, or if anything has been damaged during transport, please contact AKVA immediately.

Contact information is found in the back of this manual.

1.3 Personnel safety

Use of personal safety equipment, such as safety vest, is mandatory when working on or by the sea and cages. This also applies when installing the AOS AKVA Sensor Buoy Current.

1.4 Sensors, cables and blind plugs

The head of the Doppler sensor does not bear rough treatment, such as shocks and concussions. Because it sticks out from the bottom of the sensor buoy, handlers must be extra cautious when moving and handling the buoy. When it is being transported, unwrapped from the packaging, when moving and taking it out of the sea, as well as during storage, the sensor head must always be protected against any damages.

Blind plugs must always be attached to the AOS Box contacts whenever the sensors are not connected. This is the safest way to avoid corrosion damages when there is a risk of sea spray.

Avoid twists in the sensor cables, and make sure that all cables are damage free when they are connected to the AOS Box.

1.5 Disinfecting the equipment

If equipment, cables, suspensions or other parts of the AOS AKVA Sensor Buoy are being moved from one site to another, it is decreeded by law to disinfect them to prohibit contamination. We recommend rinsing everything with fresh water after disinfection, because of the corrosive effect disinfecting fluids may have to various materials.

1.6 Bad weather

Check all suspensions and all other equipment after stormy weather, including buoy, sensor, ropes, stabilization weight and mooring. If anything is out of order or damaged, contact AKVA immediately for repairs and corrections. Loose equipment may cause severe damages to cages.

2 Information

This user manual is part of the equipment delivered with AOS AKVA Sensor Buoy. Keep the manual for as long as the AKVA product is being used, and make sure that all changes to the equipment are noted in the back of this manual.

Thank you for choosing AKVA group ASA as supplier for your sensor equipment. Do not hesitate contacting us for more information regarding installation, use or maintenance for AOS AKVA Sensor Buoy or any other AKVA product.

The purpose of this manual is to make the user install, use and maintain AOS AKVA Sensor Buoy in a safe and economical way. The manual will show how to install, use and maintain the product, as well as hopefully answer most day to day questions. If there is anything relevant this manual does not explain or answer, please contact us for assistance and help to find a solution to any problems. Contact the AKVA service department, your subcontractor, your local AKCA office or our main office in Norway for assistance and help.

2.1 How to use this manual

This manual describes how to install, use and maintain AOS AKVA Sensor Buoy in the best and safest possible way. This entire manual must be read and understood by ALL users prior to installation. Site owner and farm manager are responsible for that all personnel and users know and understand the contents of this manual.

Before the first chapter, is a table of contents. The headlines works as links to their respective chapter in the .pdf-file.

Chapter 1 is the most important chapter of this manual, and includes safety precautions ensuring safest possible use.

Chapter 2 contains information about AKVA group, the product, AOS AKVA Sensor Buoy, as well as this manual instruction.

Chapter 3 describes how the users can access the Realfish website, chapter 4 gives a thoroughly overview over the user interface and its different pages. How to treat the sensor buoy when receiving it, and how to prepare the buoy for launch and use is shown in chapter 5, and chapter 6 instructs the launch and mooring in sea water. How to change the batteries is shown in chapter 7, and chapter 8 shows the buoy maintenance procedures.

Four appendixes are found in the back of the manual: Index, with links to the rest of the manual in the .pdf-document, a deviation form for all deviations with the system and the product, pages for notes about new and extra information are also in the back of the manual, and in the last pages are AKVA contact information found.

This entire manual must be read and understood, and used as aid during installation of AOS AKVA Sensor Buoy

2.2 About AKVA group

With four main brands, AKVA group ASA is a world leading supplier of technical aquaculture equipment. Since 1980 we have developed and produced fish farming equipment, both for cages at sea and for land based hatcheries. AKVA represents an industrial standard, which is presumed to be the turn key to the future. Research, project management, fast deliveries and customer follow-up have been our focus to ensure that we contribute to a positive development within the agriculture industry. Our goal is to deliver the best possible and most cost efficient equipment in order to keep preserving sustainable farming.

We have a wide variety of products, for example: plastic and steel cages, high pressure washers, net washers, boats, feed barges, feeding systems, cameras, sensor systems, under water lighting, software for fish farming and recycling systems.

AKVA has a continuous development of products, and we continue to improve product safety, functions, range of use and reliability. The purpose of this manual is to enable users to install, use and maintain the AOS AKVA Sensor Buoy in a safe and economic way.

All of our equipment is pre-installed, tested and delivered from our own production department. This means that our customers have total control over which components you can choose from, grouping collocation, testing and deliveries. Our production staff consists of people with great expertise and engagement for producing the best possible products for you. Having our own production site gives you excellent service in case something should go wrong, or if you are in need of any assistance. Our service staff is available on the telephone or on location in order to assist you if necessary. Safety, both for users and equipment is our main focus when developing products and product manuals.

2.3 About the AOS AKVA Sensor Buoy

Controlling environmental data such as temperature, dissolved oxygen, salinity and ocean current conditions are crucial factors for when feeding fish, as well as during other processes, such as sorting, delousing, and bringing fish to and from locations. Ocean currents are seldom constant, and prognosis will therefore be useless to use in aquaculture. In most cases, realtime measurements will be the only way to provide correct current values. For best possible overview, measuring currents in several depths will be necessary.

Norteks "Autonome Online System" (AOS) offers full control over environmental status at all times for all locations, and the data is provided real time as well as logged for later analysis. In AKVA group feeding software these measured values are displayed and logged, and may also be used to set up feed rate, -timing and -amounts for each cage and each location. The Sensor buoy is a complete data acquisition solution consisting of a local power supply, data transmission and web data access.
Correct feeding is turn key for achieving good fish breed revenues. Knowledge of environmental conditions is a smart investment for securing the bottom line.

AOS AKVA Sensor Buoy provides overview over values such as current speed and directions, oxygen saturation and salinity in the surrounding area of any fish farming site.

Current knowledge is important for several processes, and may help the users in various processes:

- avoiding fish escaping during operations, such as delousing with tarpaulin
- avoiding pellets escaping from the cage before the fish reaches them
- surveying locations before applying for new concessions

2.3.1 Important regarding current directions

When the web site shows that main ocean currents direction is N (north), the current moves from south to north. Western (W) current moves from east and is moving east. Currents are thus named after the direction they are moving to.
This deviates from how we speak of wind directions which are named after the direction it moves from.

2.3.2 Technical specifications Sensor Buoy

Height	8.2 feet (250cm)
Diameter	1.18 feet (36cm)
Width, including handles	1.97 feet (60cm)
Height above surface	3.28 feet (approx. 100cm)
Weight	approx. 100 pounds (45kg)
Material, buoy	Polyethylene (PE)

2.3.3 Equipment in the Sensor buoy

1

2

3

The upper part of the sensor buoy is called upper buoy chamber, and the chamber lid contains a marking light **(1)** with belonging battery pack **(2)**, and the AOS Box **(3)** is placed inside the chamber.

Three different sensors may be connected to the AOS Box in addition to the Doppler sensor: 3 oxygen sensors, 3 salinity sensors or a combination of these (not more than 3 of these sensors, with a total of 4 sensors including the Doppler).

4

The long middle part of the buoy works as buoyancy for the entire sensor buoy, and all sensor cables are thread through cable

5

The AQP-bracket **(4)** is used to attach the sensor to the bottom part of the buoy. The Doppler sensor **(5)** is attached to the bottom through the bottom chamber of the sensor buoy.

6

A bracket for attaching the anchorage shackle **(6)** is founded into the bottom of the sensor buoy, right next to the Doppler. This shackle is made of acid proof, non magnetic material, and will not interfere with any sensors near by. Oxygen and salinity sensors will hang below the buoy, in up to three different depths.

Read more about the sensor buoy equipment:

- Preparing the marking light: chapter 5.2
- About the AOS Box: chapter 2.3.4
- Preparing the AOS Box: chapter 5.1
- About the Doppler sensor: chapter 2.3.5

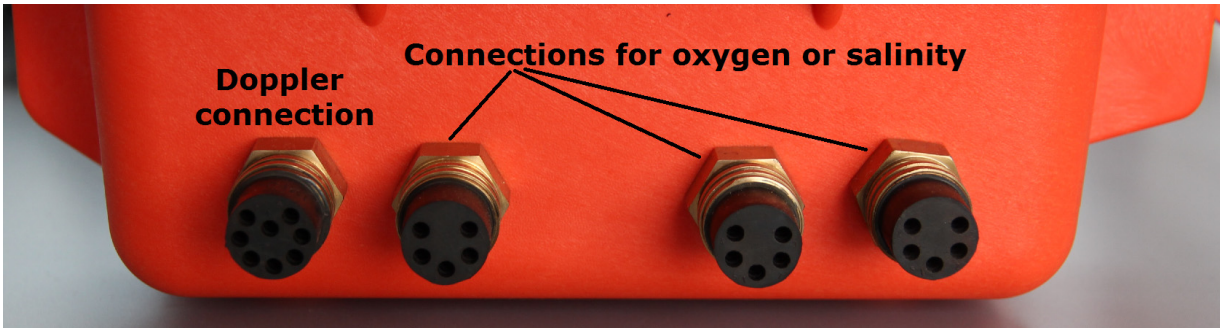
2.3.4 About the AOS Box

The AOS Box is an independent system for measuring oxygen, salinity and currents in the sea. AOS is short for Autonomus Online System, and this is a flexible system run on separate batteries and communicates via an Internet connection.

Standard communication is an Iridium satellite connection. Measured values from connected sensors will be displayed in websites for each location, providing easily accessible data for its users. Doppler, oxygen- and salinity sensors connected to the box will measure values from the buoy's surroundings, and these values will all be continuously be displayed in the website as Iridium Satellite service is available. It is important that the buoy is placed outdoors, and with open "sight" towards the sky and the satellite that receives and transmits the signals.

The Doppler sensor is set to measure the main current in the area (direction and speed), the oxygen sensor measures oxygen saturation in the area, and salinity, of course measures salinity in up to three different depths in the location area.

The Doppler cable may only be connected to the contact closest to the box handle. The other three contacts fits both salinity and oxygen sensors, and may be used for one type as well as a combination of these two sensor types.



The AOS Box contains:

- ON/OFF-button **(1)**
- Internal antenna **(2)**
- 3 batteries **(3)** *(underneath the cover)*

Technical specifications:

Dimensions

- weight: 4,8kg
- dimensions: 270 x 250 x 130mm

Operating voltage

3 batteries, 100Wh alkaline batteries

Environment

Operating temperature: -20°C to +45°C

Data communication:

Data transference: Iridium

Data presentation:

Internet: http://realfish.akvagroup.com

2.4 The sensors

2.4.1 Doppler sensor

The Doppler sensor is installed in the bottom of the sensor buoy, and will measure current direction and speed at 5, 11 and 15m below the surface. The cable goes from the AOS Box that is placed in the upper chamber of the buoy and down to the top of the Doppler sensor.

No moveable parts provides minimum maintenance, apart from outside cleaning.

Technical specifications:

Measuring area	0-50 ºC
Capsule	Polyethylene

The principle:

The Doppler sensor registers direction and force of ocean currents in three different depths. The measured signals are transferred via the sensor cable to the AOS Box. From the antenna in the AOS Box, the signals are transferred via Iridium satellite to Nortek that calculates values that are presented in the web site where users can read and log them. The Doppler sensor calculates a certain amount of signals, and the values that are available in the website, are calculated average values.

Nortek operates a backup service that stores all information that has been transmitted via the satellite network. Full current datasets are stored in the instrument memory.

2.4.2 Oxygen and salinity sensors

Both salinity and oxygen sensors have one red, one blue and one green type, and these may measure in three different depths where the buoy is installed.

It is not possible to have two similar oxygen or salinity sensors of the same colour connected to the same AOS Box, however it is possible to use one red, one blue and one green sensor of the same type connected to the same box. On the other hand, it is possible to use the red oxygen sensor with the red salinity sensor, their signals will not conflict with one another in the transmission process.

Oxygen sensor

The oxygen sensors are optical sensors, and provide stable measurements for long periods because of the use of membrane measuring. The membrane will not be not be expended providing correct maintenance. Oxygen sensor measures % saturation and the website shows these values in mg/l based on a constant salinity value. Default salinity is set to 35ppt, contact Nortek if this value should be changed to accommodate the specific locations.

See chapter 4.2 for how the measured oxygen values are presented in the graph.

Sensor type	Oxygen sensor
Brand	Insite IG, Dissolved Oxygen Model 400
Measurement area	0-25ppm
Accuracy	1% of read value, or 0.02ppm
Resolution	- 0.01ppm of read value < 4ppm - 0.1ppm of read value > 4ppm

Salinity sensor

The salinity sensors measure conductivity and temperature in the area where they are placed. Nortek calculates salinity from these values, and this is presented in the website.

The right y-axis in the salinity graph shows temperatures, the left y-axis shows salinity in ppt, and the x-axis shows time.

See chapter 5.1.7 for how the measured salinity values are presented in the graph.

Sensor type	Salinity sensor
Brand	Ponsel CTZN: Inductive Concuctivity
Measuring area	0-100mS/cm (conductivity) 0-72ppm (salinity)
Accuracy	
Resolution	~0.1ppm

3 Receiving and preparations

The AOS Box can only be opened indoors

Whenever sensor cables are disconnected from the AOS Box, blind plugs must cover the connection points

Handle the sensor buoy carefully when unpacking it. For preparation procedures, make sure it does not roll around on the foundation

3.1 Preparing the AOS Box

When receiving the Sensor buoy, it is important to make sure that the entire order corresponds with the service note. If anything is missing, or something has been damaged during transportation, please contact AKVA group immediately. Contact information is found in the back of this manual.

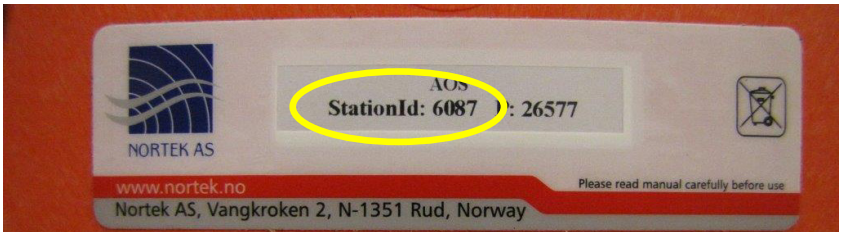
Procedure

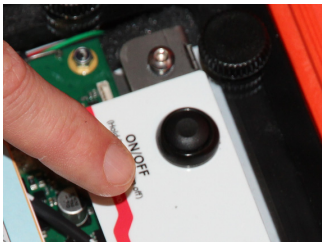
1 Remove the bolts and take off the sensor buoy upper chamber lid to access the AOS Box

Be careful and make sure the status lamp is not damaged when the lid is being removed

2 Take the AOS Box out of the upper chamber and open it

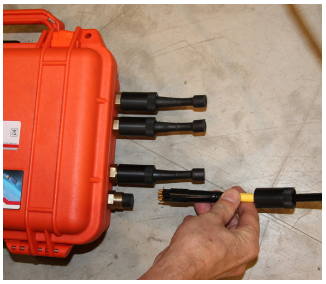
3 Note the StationID from the inside of the AOS Box lid





4 Activate the AOS Box by pressing the ON/OFF button in the panel inside the box for a few seconds. An orange led light will light up for about 80 seconds indicating that the start up was successful

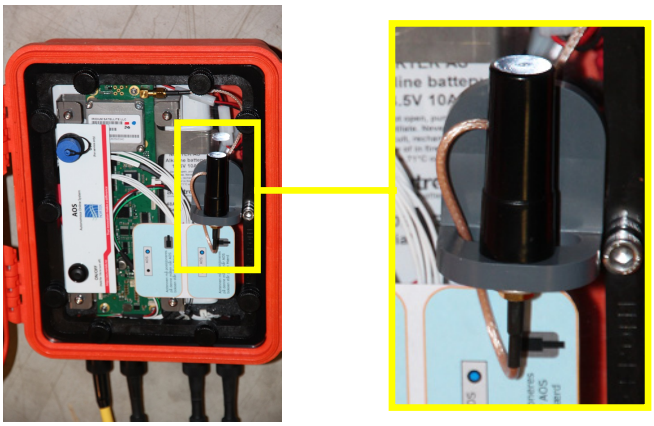
A simple press to the button will have no effect on the system once it is switched on



5 Remove the blind plugs from the contacts, and connect the sensor cable to the box

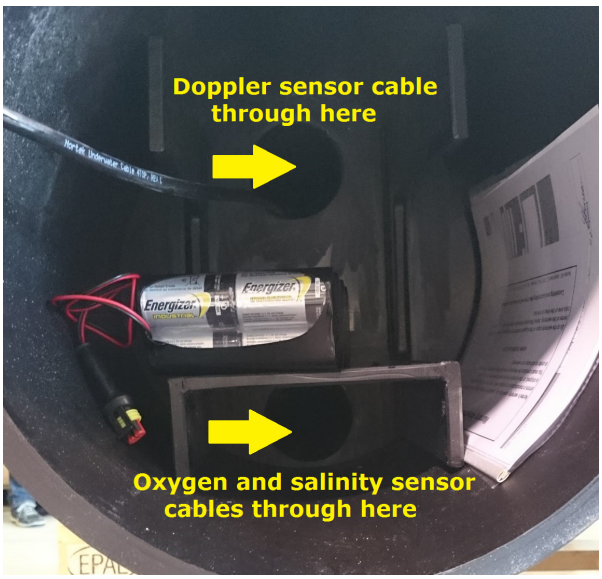
See chapter 2.3.4 for instructions to which sensor cable goes in which AOS Box contact

6 In order for the AOS Box internal antenna to transmit signals to the Iridium satellite, it needs continuous signal and must therefore point upwards inside the buoy. Therefore, place the AOS Box as shown in the illustrations below, the contacts must point downwards in the buoy



7 The Doppler cable should be connected to the Doppler sensor as well as thread through the Doppler longitudinal chamber when the buoy is delivered. Curl the excess cable carefully around the AOS Box in the upper chamber.

Salinity and oxygen sensor cables must be thread through their longitudinal chamber, the opening is found behind the marking light battery pack:



8 Place the AOS Box inside the buoy upper chamber as shown in the image below to the right:

9 Proceed to chapter 3.2 for marking light preparations

3.2 Preparing the flashing light

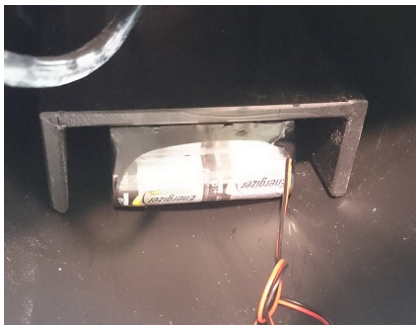
When the marking light is connected to batteries, it will start flashing when the outdoor lights is less than 50 lux.

Flashing pattern is 0,25 sec on and 1,25 sec off. Expected operating life is 3 months if the lamp flashes continuously with this pattern.

Procedure

1 Connect the marking light cable to the battery package from inside the sensor buoy's upper chamber

2 When connected, leave the battery package in the marking light opening in the sensor buoy upper chamber



3 Place the Sensor buoy's upper lid back to its position, and fasten it with the bolts. Make sure that the lid sits tight to avoid sea water entering the inside of the buoy.

3.3 Suspension

The buoy suspension is attached via the acid proof shackle in the bottom of the buoy.

Use a nylon rope with dimensions:

l = 32.8 feet, Ø = 0.47 inches *(l = 10m, Ø = 12mm)*

to fasten the stabilization weight, 60kg.

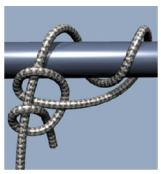
The rope is fastened to the acid resistant shackle in one end, and the weight in the other end.

Attaching the shackle:

The shackle should already be attached to the sensor buoy bottom when delivered, but if it is not, or if it needs to be changed, use the following instructions:

1 Step the shackle bolt through the bracket eye in the bottom of the sensor buoy, and fasten it by using two wrenches, and make sure to tighten sufficiently

2 Thread the nylon rope through the shackle and tie a double half hitch (or an equivalently strong knot), and ensure that the rope and knot manages both the stabilization weight as well as movements in the sea water



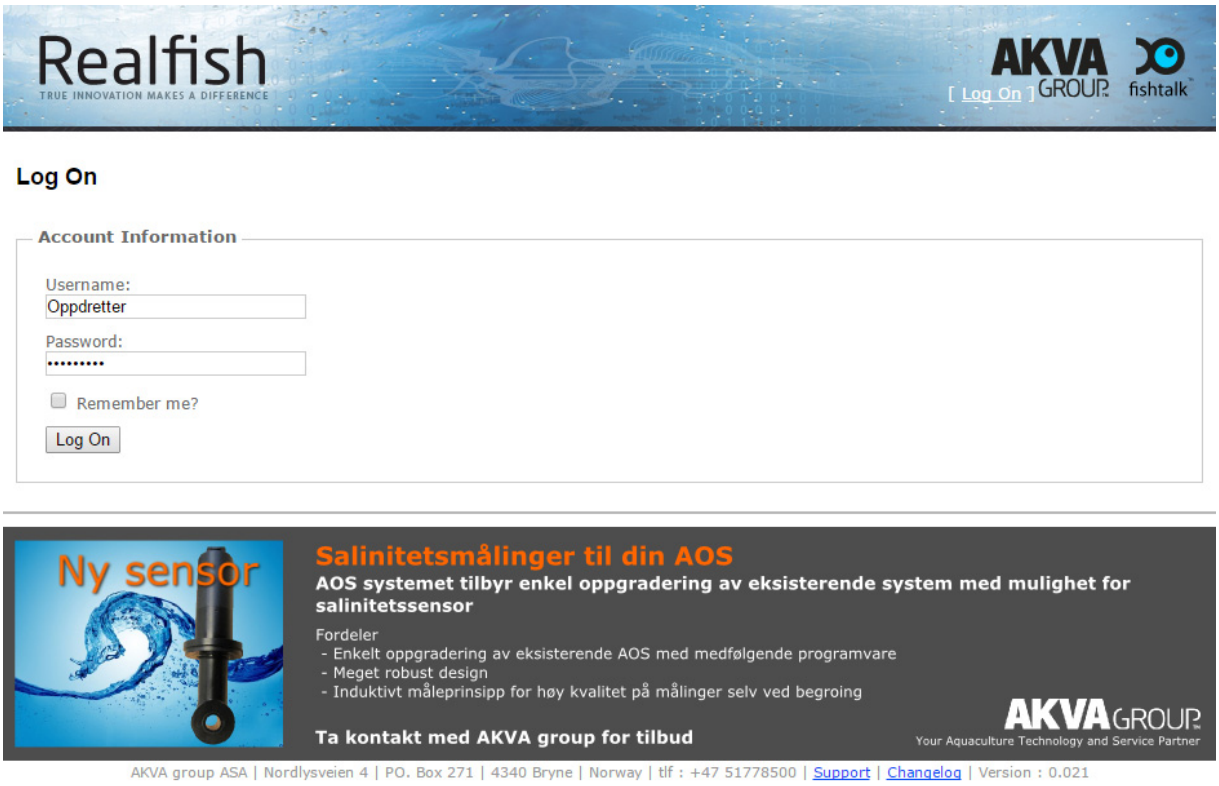
3 Attach the stabilization weight to the other end of the rope. Use double half hitch (or an equivalently strong knot)

4 The sensor buoy is ready for launching in the sea.

4 Website - access

After the AOS Box inside the AOS AKVA Sensor buoy has been activated and placed inside the buoy upper chamber as described in the previous chapter, measured values will be available in the users own customized website:

http://realfish.akvagroup.com


Realfish
TRUE INNOVATION MAKES A DIFFERENCE
[Log On]
Log On
Account Information
Username:
Oppdretter
Password:
Remember me?
Log On
Ny sensor
Salinitetsmålinger til din AOS
AOS systemet tilbyr enkel oppgradering av eksisterende system med mulighet for salinitetssensor
Fordeler
- Enkelt oppgradering av eksisterende AOS med medfølgende programvare
- Meget robust design
- Induktivt måleprinsipp for høy kvalitet på målinger selv ved begroing
Ta kontakt med AKVA group for tilbud
Your Aquaculture Technology and Service Partner
AKVA group ASA | Nordlysveien 4 | PO. Box 271 | 4340 Bryne | Norway | tlf : +47 51778500 | Support | Changelog | Version : 0.021

To get access to the Realfish logging sites, Nortek must be contacted. They will provide user name and password. Follow the instructions in the next page for access.

AOS web access Quick Guide

1 Collect following information:

a The AOS Box ID number
This is found on the inside of the AOS Box lid. This is the identity of the case and all remaining information is linked to this ID.

b The company name
This information will appear in the web page

c The location name
This information will appear in the web page

d GPS coordinates for the AOS Box
This information is the basis for placing of the flag in the first page in the web page

e Descriptions for the sensors (2 or 3 different)
Colour, whether it is in- or outside of the cage and depth. This information will also appear in the web page, making it easy to find data for each sensor

2 Send all the information above to: support@nortek.no

3 Receive user name and password and make sure to save the e-mail and note the information in an additional safe place

4 Go to: http://realfish.akvagroup.com

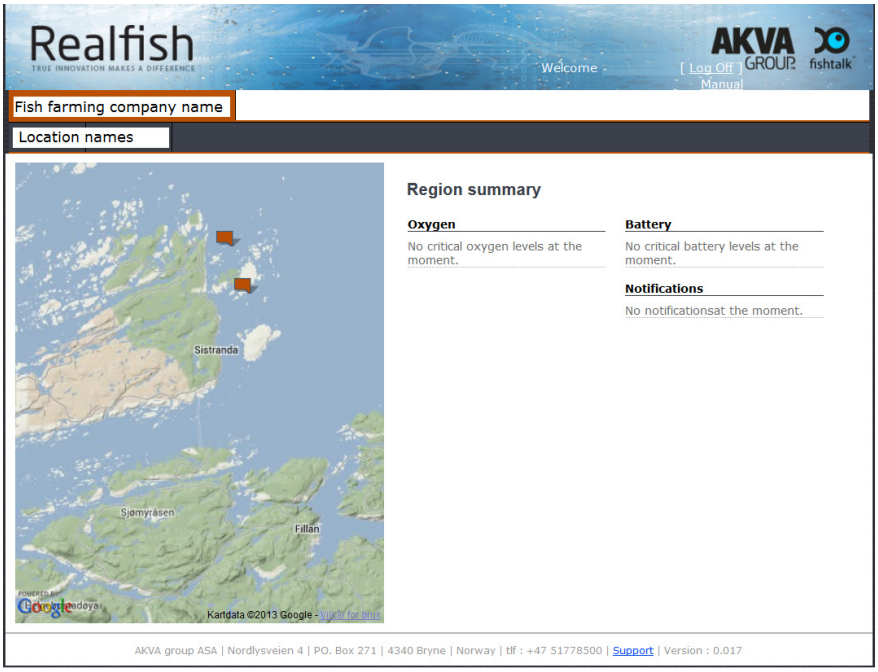
5 Type user name and password and click on 'Log on'

6 The data logging from the registered sensors may start and seen from anywhere at anytime.

! *A laminated quick guide similar to this page is found inside the AOS Box case when delivered*

5 Website - use

The start page presents an overview to the regions for your company and shows geographic placement of your locations in selected region.



Under each region tab is a map showing all locations registered in the chosen region. Each location or buoy is registered as a flag in the map. Choose location by clicking the location tab or the flag in the map.

Under Oxygen any measured oxygen saturation measurements from each sensor buoy will appear if the values are critical:

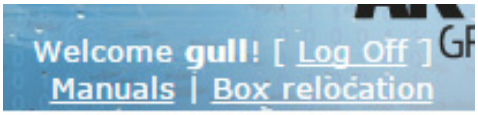
- Red colour: critical - oxygen level below 60%
- Yellow colour: alarming - oxygen level around 60-75%
- Green colour: ok - oxygen level above 75%

Battery shows critical battery levels for registered boxes.

Notifications will show in the interface, however only when the oxygen levels are critical for one or more AOS Boxes in the region.

5.1 Top functions

In the right side of the blue top part of the website, are four different functions:



Welcome [location name] !

- shows which location is logged on. This is useful for users who have access to several locations in one log-in

Log Off

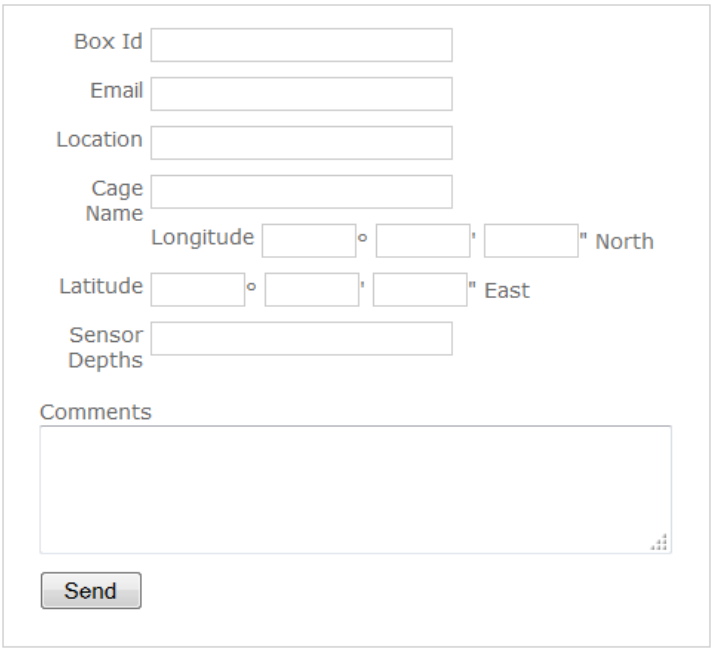
- logs off the user and opens the log on page

Manuals

- opens pdf user manuals in the website

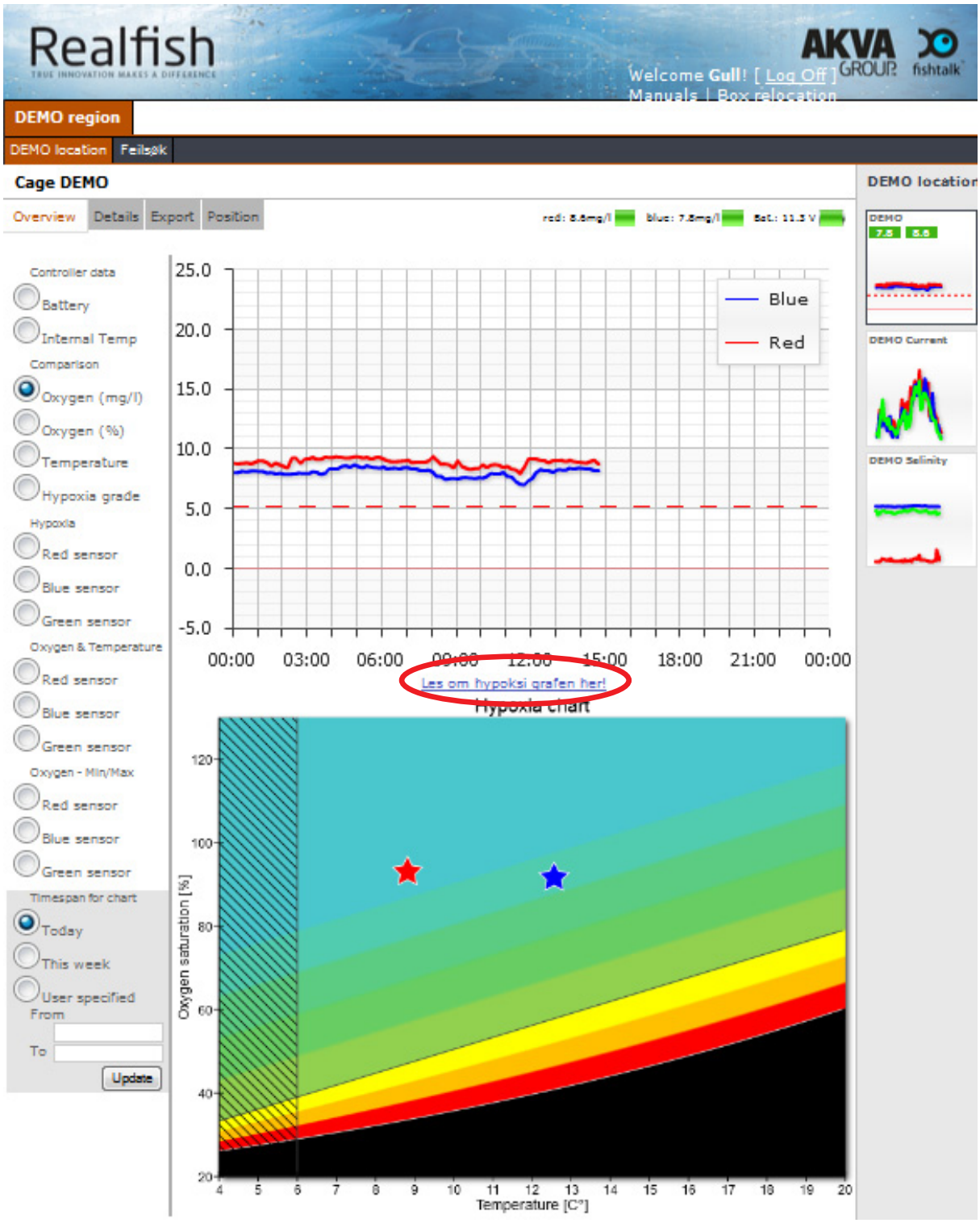
Box relocation

- opens a form that must be filled out and sent if and when the AOS Box is being relocated to a new cage or location:



5.2 Overview

Overview for any location will show either measurement results for oxygen, salinity or currents for one sensor from the location:



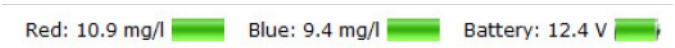
Read more about Hypoxia by clicking on the blue link between the oxygen graph and the hypoxia chart (marked with red ring).

5.2.1 Miniature frames

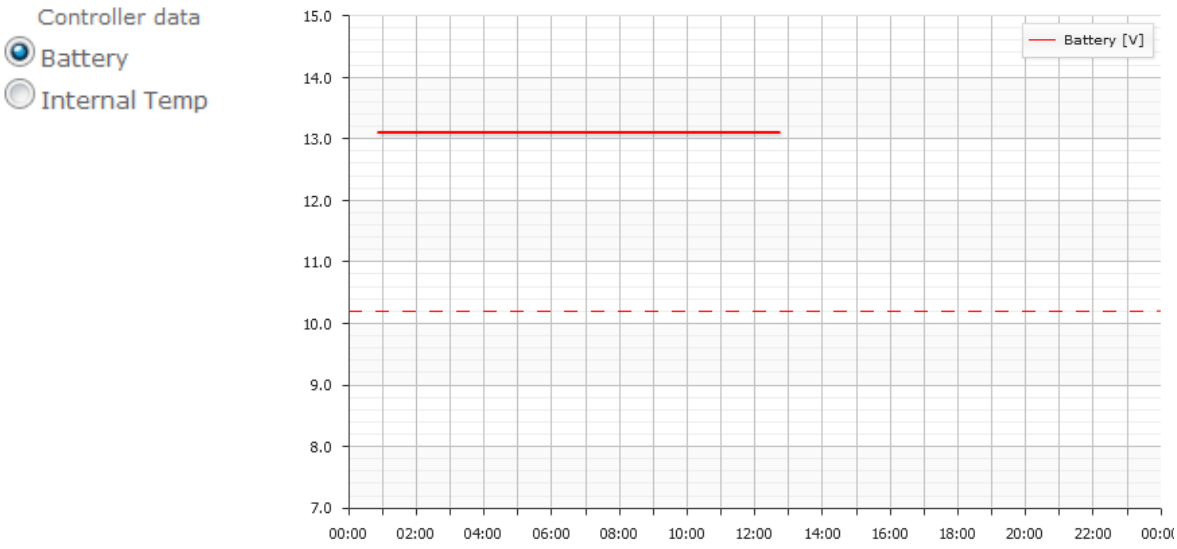
The miniature frames in the right column of the website show a simple overview of the measurements, oxygen, salinity and current wherever these sensors are registered and connected to the system. Measured values are shown in correct colours, where for instance green oxygen levels show that everything is ok at the moment, and yellow levels indicates that something is wrong and needs special attention right away.

5.2.2 Controller data

Controller data battery level is shown in the right side above the graphs:



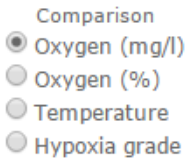
The battery level may also be shown graphically as a function of the time:

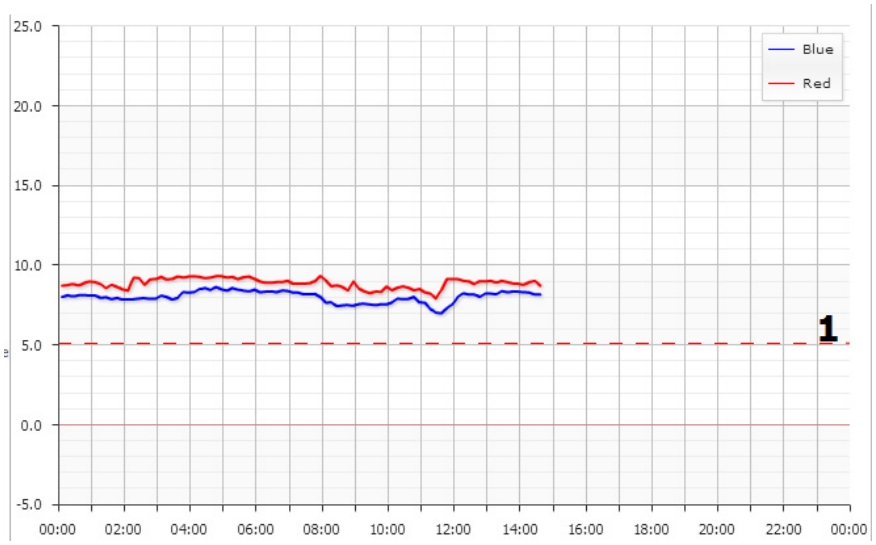


The internal temp. function shows temperature measurements from the inside of the AOS Box as a function of the time. Contact AKVA service personnel immediately if unexpected variations in this temperature is discovered.

5.2.3 Comparison

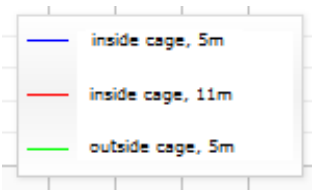
Oxygen level may be shown graphically as mg/l or %, and shows all measurements as a function of the time. This graph shows red and blue oxygen sensor measurements in mg/l for selected time span. Oxygen % is saturation values.





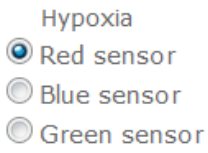
Oxygen levels in the mg/l-graph also shows a red dotted line (1). This line indicates critical oxygen level. If the graph for measured oxygen is below this value, site manager or other responsible personnel must firstly check the sensor and its membrane. If the sensor is placed inside the cage, sprout concentration in the net must also be controlled. If sprout is not the reason for the decreased measurements, contact AKVA service personnel for further inspection of the problem, and if possible, use an alternative oxygen sensor to find out if the levels are too low, or if it is the sensor that causes these measurements.

In case of too low oxygen levels, take immediate action to keep the fish from suffering from hypoxia, and stop feeding and any stress as soon as possible. Read more about hypoxia and how this effects the fish in chapter 5.2.4.

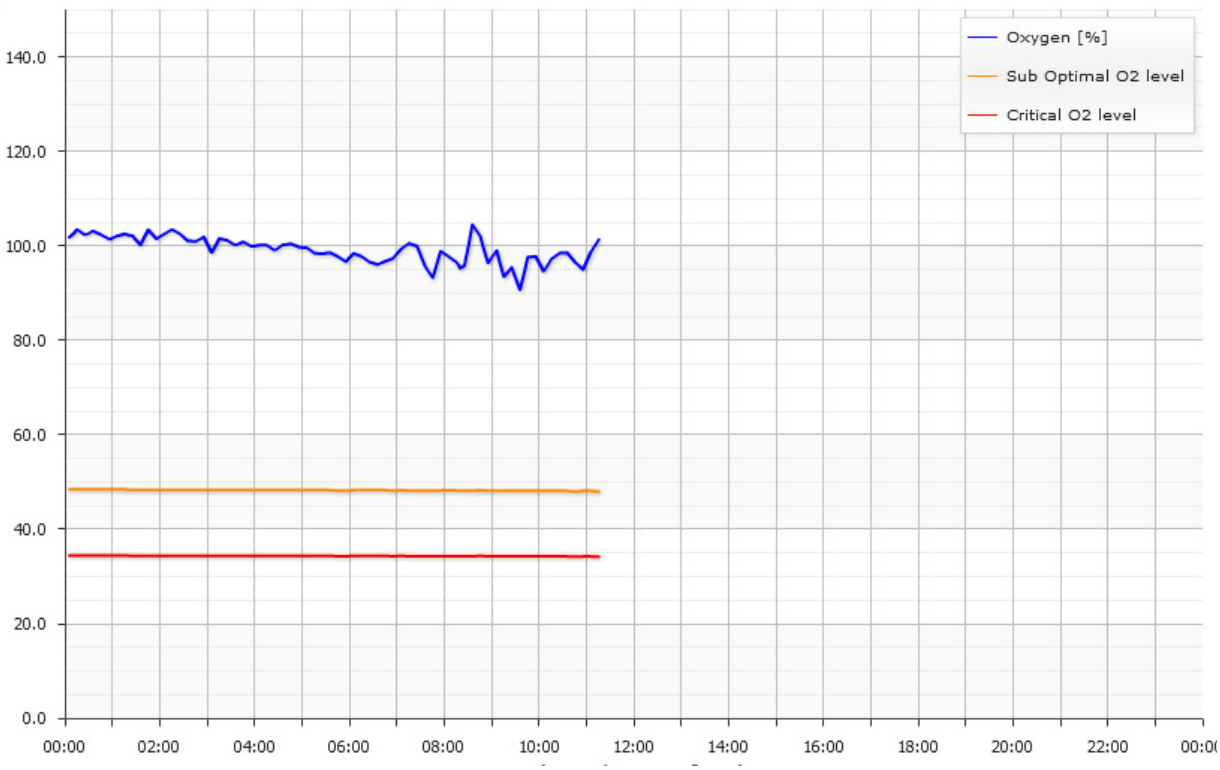


Sensors may be named after where they are placed. Naming is done by Nortek before starting to use the sensors.

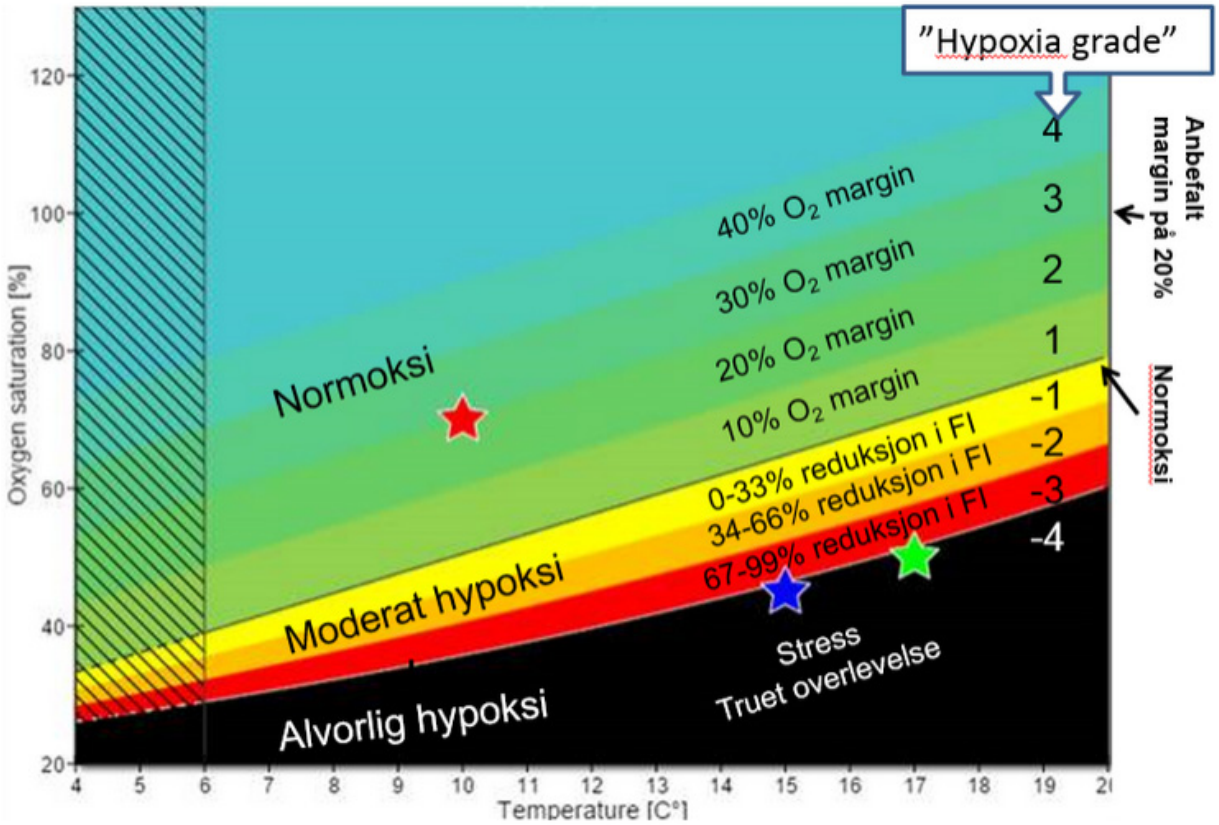
5.2.4 Hypoxia



Hypoxia is graphically represented for one oxygen sensor (choose colour) at a time. Choose desired sensor in the menu on the left, and the oxygen values are shown in the graph, as saturation as a function of the time span. Yellow and red lines indicates critical values as function of the water temperature.



Hypoxia diagram colour coding



All values in the graph are based on general tolerances for post-smolt salmon under 1kg

The stars in the diagram represent measured values from the three different oxygen sensors (blue, red and green).

When the oxygen level is above the Normoxia-line, when the Hypoxia grade is 1 or higher, all is ok.

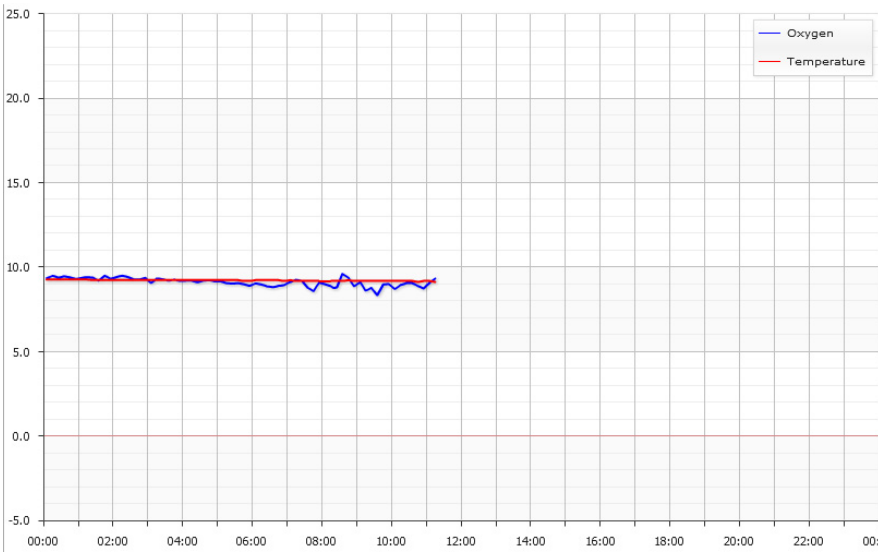
When the oxygen level goes below the Normoxia level, and the hypoxia level is moderate, between -3 and 1, it is recommended that feeding is reduced. If the Hypoxia level goes below -3 all feeding and any other disturbance causing fish stress must be stopped because the survival of the fish is threatened within this Hypoxia area.

We strongly recommend that all fish farming sites operates with at least a 20% Normoxia safety margin, this meaning using an Hypoxia grade at minimum 2.0.

5.2.5 Oxygen and Temperature

Oxygen & Temperature
Red sensor
Blue sensor
Green sensor

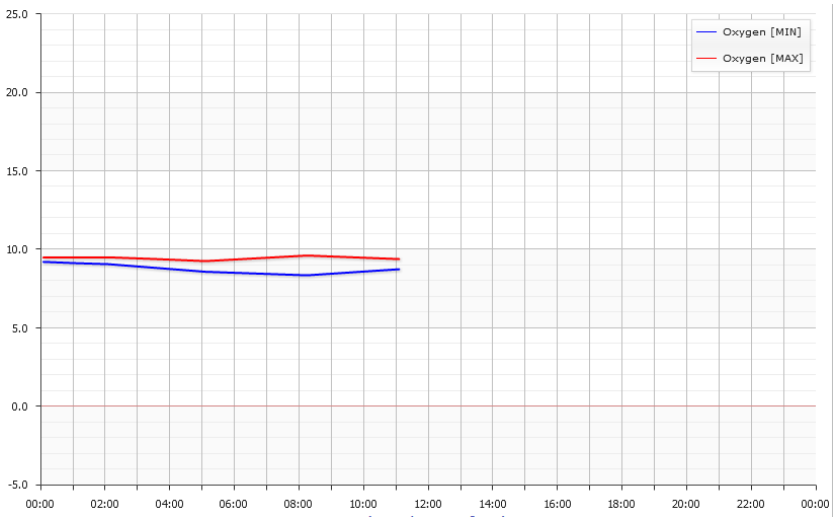
This function show two separate graphical measurements; one for oxygen and one for temperature from one of the used sensors (red, blue or green sensor) at a time.
The blue graph shows oxygen values as function of time, and the red graph shows temperature values as function of time.



5.2.6 Oxygen min/max

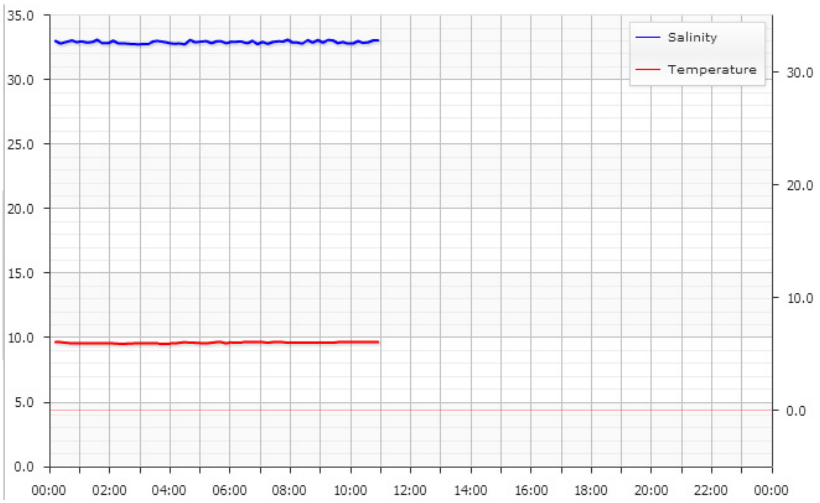
Oxygen - Min/Max
Red sensor
Blue sensor
Green sensor

This diagram shows maximum and minimum oxygen measurements for every third hour. Red line shows the highest measurement from the three hour period, and the blue line shows the lowest measurement for the same time interval. This provides a more accurate overview of the oxygen levels, as it shows larger time intervals. These measurements are stated as mg oxygen per litre water, as a function of time.



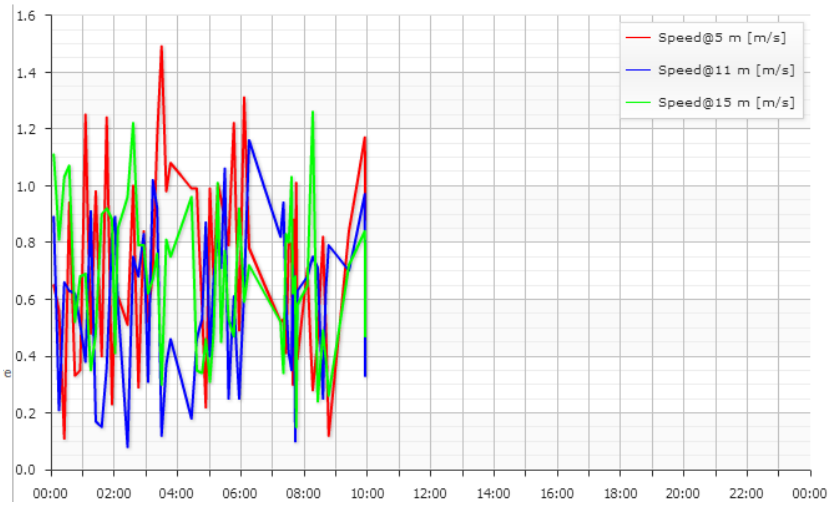
5.2.7 Salinity

This diagram shows measured salinity values from the chosen salinity sensor as a function of time.
The red line indicates temperature as function of time.

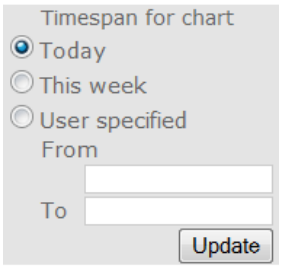


5.2.8 Current speed

This graph shows measured current speeds for the three different depths. Red graph indicates 5m depth, blue shows 11m depth measurements, and green shows measured current speed for 15m depth. Time is set to the x-axis, and current speed is set to the y-axis.



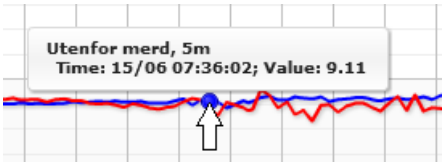
5.2.9 Timespan for chart



It is possible to customize time span for all diagrams. Choose between measurements for the current day, week or specified from one day to another.

A specific time may be shown in the charts, place the mouse pointer over desired point in the graph for designated timespan, and an information box with following information will appear:

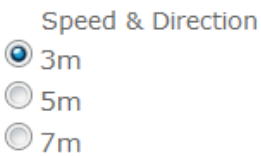
- which sensor the graph represents, and where this sensor is placed
- sensor depth*
- date and exact time
- measured value at the chosen time



The mouse pointer may be moved around over the graph, and the user may choose which time, within the designated timespan that should be displayed in the information box.

**Let Nortek know where the sensors are placed before registration in order to show this information in the information box*

5.2.10 Speed and direction

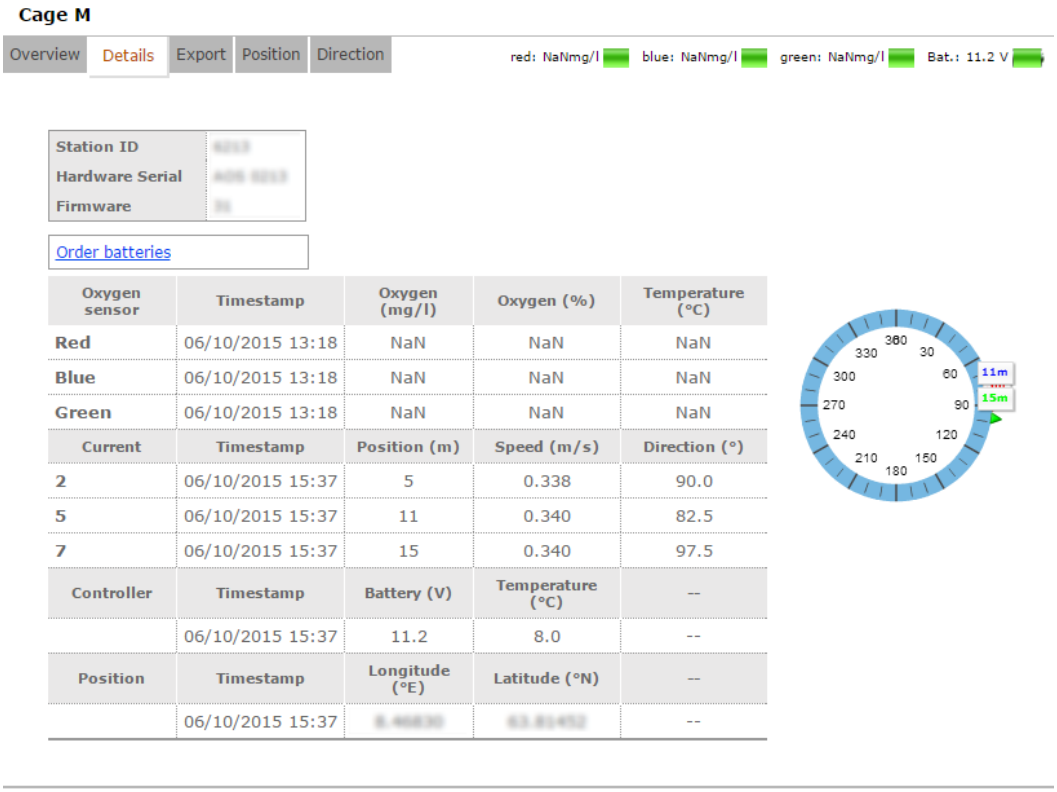


This function shows speed and direction of the measured current from three different depths where the sensor buoy is installed.

If Level 1 (here: 3m) is marked, all measurements from 3m depth will be displayed in the graph.

5.3 Details

Tables containing measurement details are found under the Details tab.



Oxygen sensor	Timestamp	Oxygen (mg/l)	Oxygen (%)	Temperature (°C)
Red	06/10/2015 13:18	NaN	NaN	NaN
Blue	06/10/2015 13:18	NaN	NaN	NaN
Green	06/10/2015 13:18	NaN	NaN	NaN
Current	**Timestamp**	**Position (m)**	**Speed (m/s)**	**Direction (°)**
2	06/10/2015 15:37	5	0.338	90.0
5	06/10/2015 15:37	11	0.340	82.5
7	06/10/2015 15:37	15	0.340	97.5
Controller	**Timestamp**	**Battery (V)**	**Temperature (°C)**	--
	06/10/2015 15:37	11.2	8.0	--
Position	**Timestamp**	**Longitude (°E)**	**Latitude (°N)**	--
	06/10/2015 15:37	[illegible]	[illegible]	--

At the top, registered information about the AOS Box is found, hereunder Station ID, serial number and firmware.

When the battery indicator turns yellow, new batteries must be ordered. This is easily done by clicking the Order batteries-link. This opens a new page with a order form that must be filled in, and the batteries will be sent from Nortek to the location address shortly.

The **Oxygen sensor** table shows oxygen measurements in both % and mg/l, as well as temperature for the same timestamps.

Oxygen sensor	Timestamp	Oxygen (mg/l)	Oxygen (%)	Temperature (°C)
Red	06/15/2015 14:32	9.10	98.63	8.97
Blue	06/15/2015 14:32	8.91	96.52	8.97
Green	07/17/2013 09:34	NaN	NaN	NaN

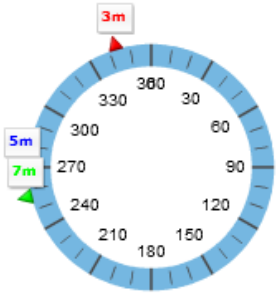
(Green sensor is not connected in the example above)

Salinity sensor measurements table shows salinity in ppt and conductivity (mS/cm), as well as temperature for the same timestamps.

Salinity sensor	Timestamp	Salinity (ppt)	Conductivity (mS/cm)	Temperature (°C)
Red	06/18/2015 10:57	2.2	4.1	8.53
Blue	06/18/2015 10:57	28.7	44.5	9.17
Green	06/18/2015 10:57	26.8	41.7	9.46

The **Current** table shows current measurements if an AOS AKVA Sensor Buoy is installed in the location. Current directions appear both in the table as well as graphically in the compass. This way, the current directions may easily be compared. Current speeds are shown in the table.

Current	Timestamp	Position (m)	Speed (m/s)	Direction (°)
1	10/14/2013 12:30	3	0.021	343.5
2	10/14/2013 12:30	5	0.056	270.0
3	10/14/2013 12:30	7	0.113	256.5



The **Controller** table shows battery status for the AOS Box, as well as temperature from inside the box. All values relates to the same timestamps.

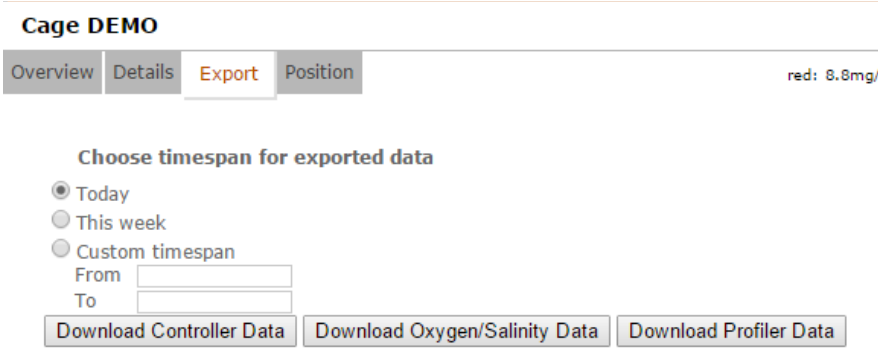
Controller	Timestamp	Battery (V)	Temperature (°C)	--
	06/15/2015 14:32	13.1	5.5	--

The AOS Box's GPS **Positions** are shown in the bottom table for the desired timestamps.

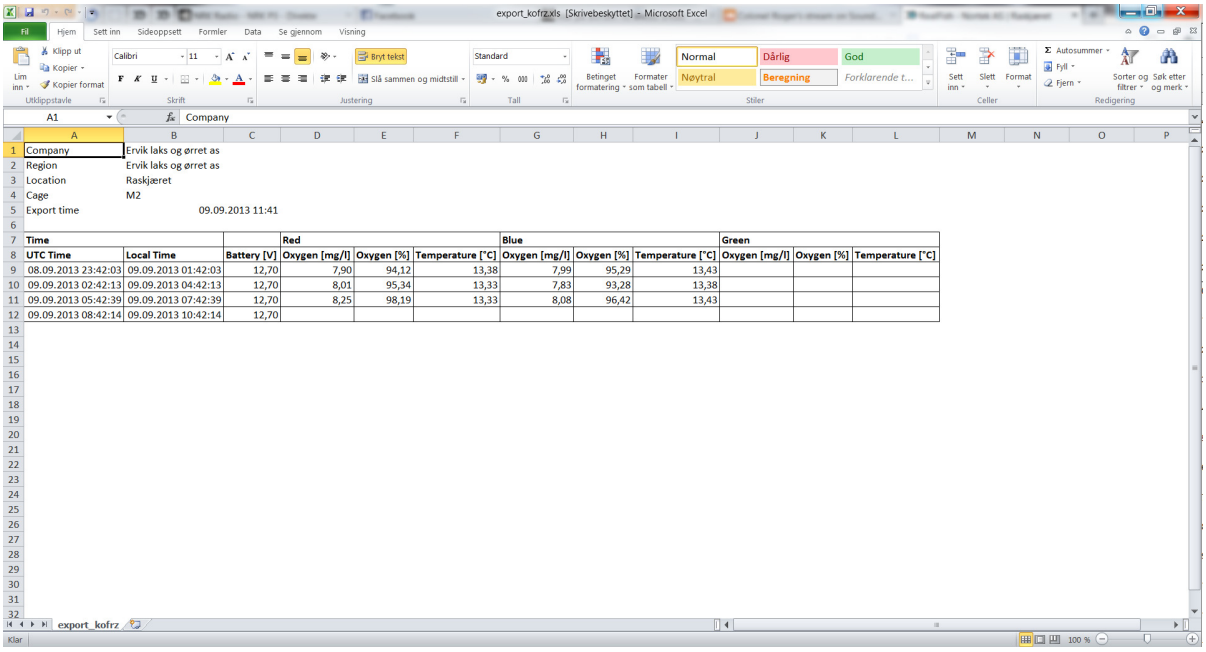
Position	Timestamp	Longitude (°E)	Latitude (°N)	--
	06/15/2015 14:32	8.87991	63.76152	--

5.4 Export

Data saved in Realfish may be exported to a computer for historical data back-up and possibility of printing reports. This makes it possible to process the information, and storing this in paper format if this is desired.



Choose desired time interval, click desired Download button, choose if and where the file should be saved, or choose open. The document will open automatically in Microsoft Excel if this program is installed on the computer.



export_kofrz.xls [Skrivebeskyttet] - Microsoft Excel

	A	B	C	D	E	F	G	H	I	J	K	L
1	Company	Ervik laks og ørret as										
2	Region	Ervik laks og ørret as										
3	Location	Raskjæret										
4	Cage	M2										
5	Export time		09.09.2013 11:41									
6												
7	Time			Red			Blue			Green		
8	UTC Time	Local Time	Battery [V]	Oxygen [mg/l]	Oxygen [%]	Temperature [°C]	Oxygen [mg/l]	Oxygen [%]	Temperature [°C]	Oxygen [mg/l]	Oxygen [%]	Temperature [°C]
9	08.09.2013 23:42:03	09.09.2013 01:42:03	12,70	7,90	94,12	13,38	7,99	95,29	13,43			
10	09.09.2013 02:42:13	09.09.2013 04:42:13	12,70	8,01	95,34	13,33	7,83	93,28	13,38			
11	09.09.2013 05:42:39	09.09.2013 07:42:39	12,70	8,25	98,19	13,33	8,08	96,42	13,43			
12	09.09.2013 08:42:14	09.09.2013 10:42:14	12,70									

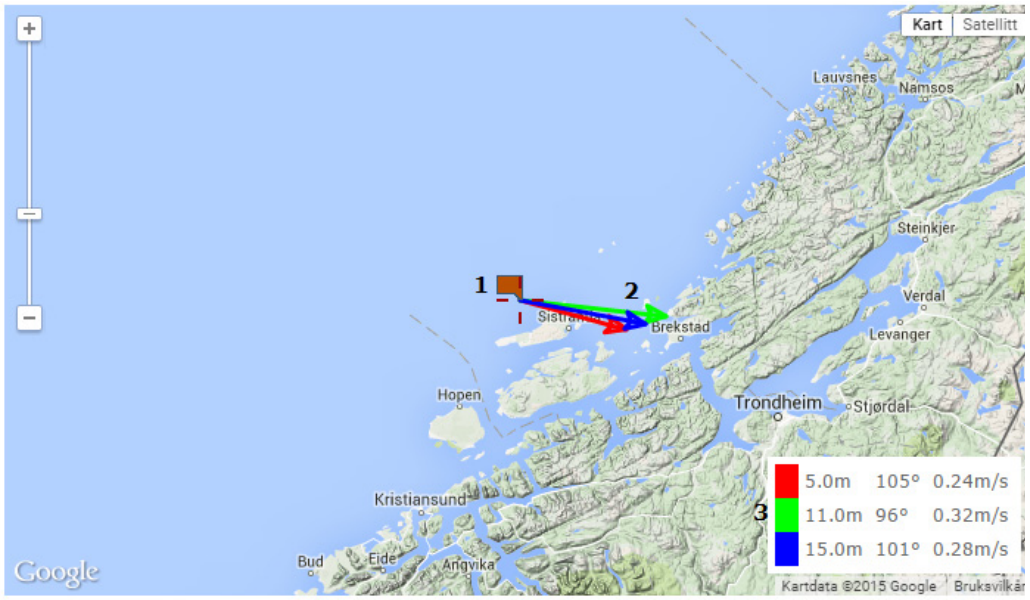
5.5 Position

The position diagram shows:

1 Placement of the AOS AKVA Sensor Buoy in the map

2 Measured direction for the chosen time (red, green and blue arrows)

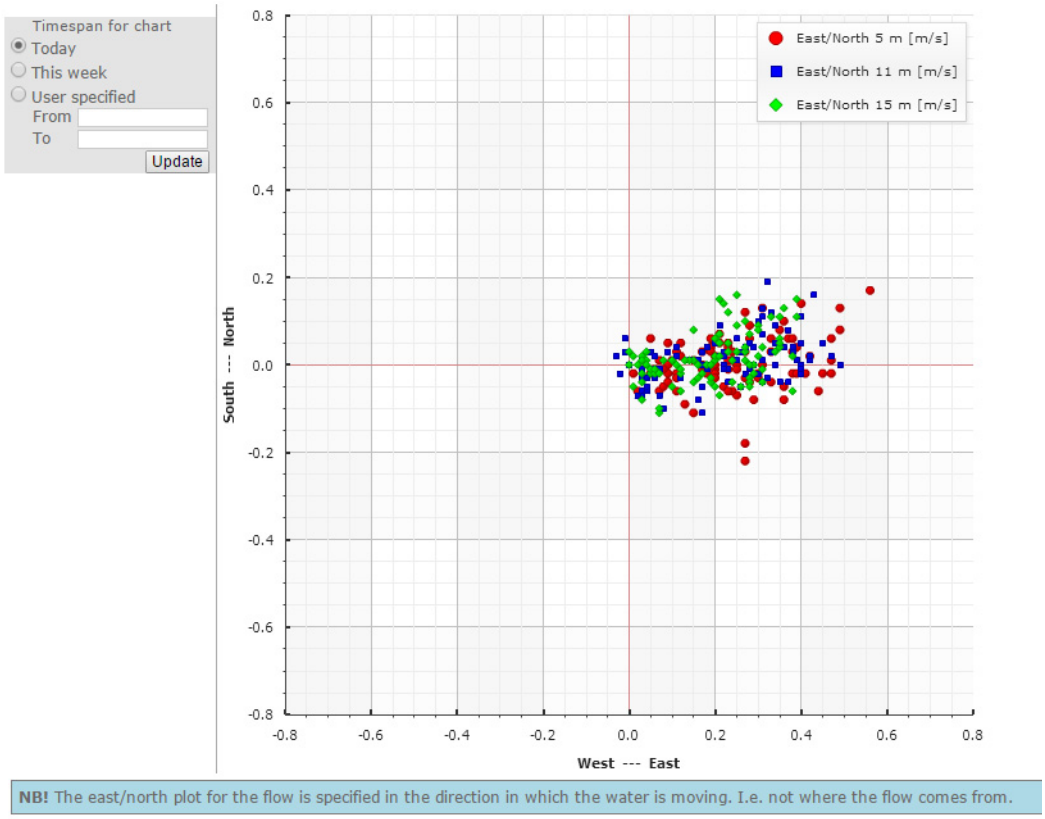
3 Measured current direction stated compared with northern direction for all three depths (here: 5, 11 and 15 meter), as well as measured current speed in meters per second (m/s).



5.6 Direction

The dots in the chart are created as a function of north-east coordinates for the three different depths (divided by colour).

For each measurement in the period of time, one point is added to the diagram as a north-east based value. This provides a "cloud" of points, showing how the current measurements are scattered, and showing how many of the measurements are north-eastern. It is possible to space out one of the measurements, by placing the mouse pointer over the description of the deep (in the top right corner of the chart).



NB! The east/north plot for the flow is specified in the direction in which the water is moving. I.e. not where the flow comes from.

6 Installation and suspensions

6.1 Check list before installation:

a AOS box is switched ON

b AOS box is placed in the buoys upper chamber with inner antenna pointing upwards

c Marking light is connected to the battery pack

d Doppler sensor cable is connected to the AOS box

e Upper chamber lid is secured tightly

f StationID is and GPS-coordinate position is noted and ready to e-mail to Nortek for registration

g Doppler is installed in the sensor buoy bottom

h Shackle is fastened to the buoy bottom bracket

Before deciding where to place the sensor buoy, these precautions must be considered:

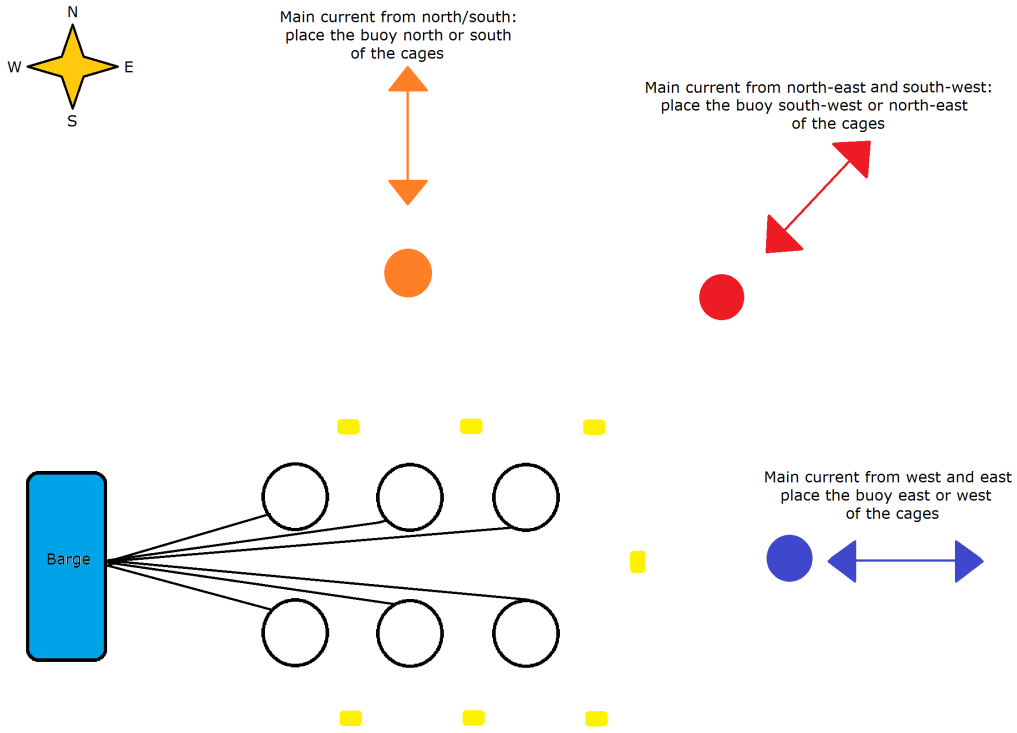
- Best possible signal access from AOS Box to the sky provides best possible results
- Do not place the Sensor buoy next to any metal constructions, these may interfere with the internal compass in the sensor and provide incorrect measurements
- Make note of the GPS-position for the buoy to indicate where the data is from. This will also show on the Sensor buoy location overview map
- Remember that cages, potential net sprout as well as the biomass inside the cages will, in most cases affect the currents surrounding the site.

6.2 Placing the Sensor buoy

The buoy must be placed at least 2-3 x diameter away from the cages and outside the frame mooring encircling the cages. This is the best way to avoid current interference from cages, biomass and sprout.

Placing the buoy according to the site (examples):

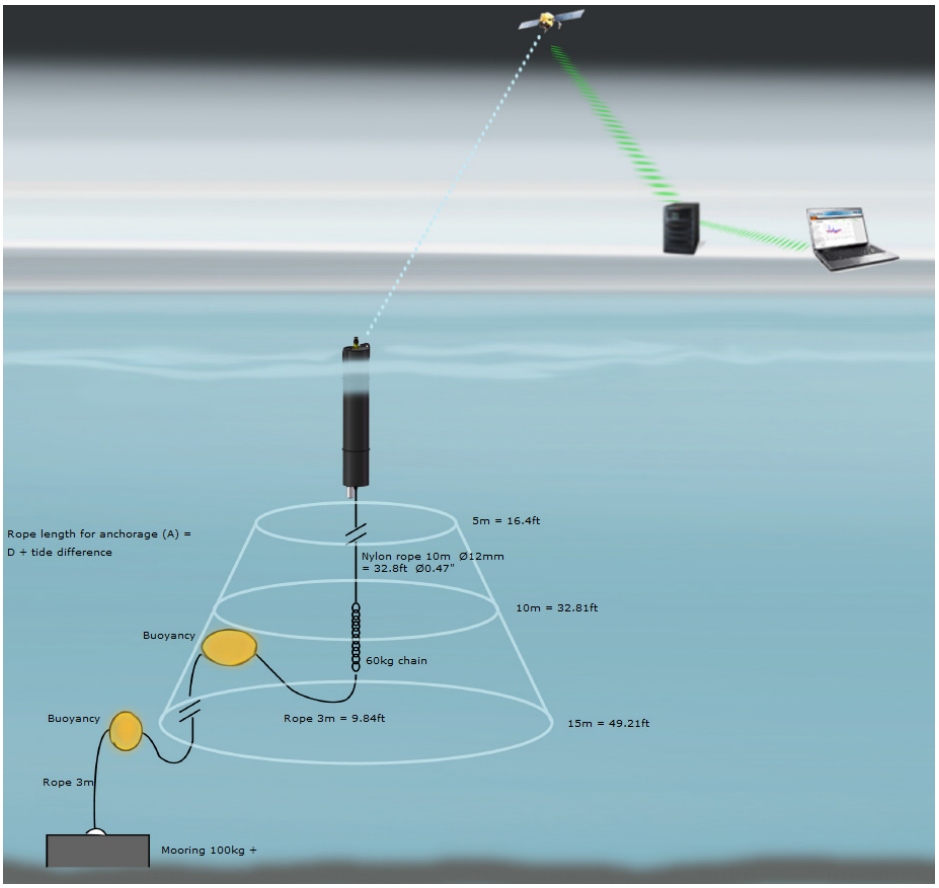
- If the main ocean current moves between south to northerly direction, place the Sensor buoy south or north of the cages
- If the main ocean current moves between southeast and north-west, place the buoy in one of these directions based on the cages
- If the main ocean current moves between west and east, place the buoy either west or east of the cages.



Information: *The ocean currents will always follow the tide, and therefore move one direction during flux and the opposite direction during reflux.*

6.3 Launching the buoy in the sea

We recommend following the mooring set up as shown in the illustration below. Because of great variations regarding depths in the different locations, this must be adjusted for each site.



Minimum length rope for anchorage:

(A) = depth + tide difference

The longer rope for anchorage, the less the buoy is affected by currents. If using shorter ropes, the buoy may be pulled under water when currents are strong. A disadvantage by using longer ropes, is that the buoy will move around, not providing measurements from the same position at all times. Therefore, anchorage rope length must be adjusted for each location.

Mandatory mooring components are the nylon rope, as described in chapter 5.3, and 60kg stabilization weight, for example a chain.

7 Changing batteries in AOS Box

AOS Box is standardly delivered with 3 alkaline 100 Wh (none rechargeable batteries) that are calculated to provide the system continuous uptime for 4-6 months. Uptime varies with number of connected sensors, temperatures and Iridium signal at the location.

The website will at all times indicate battery status for the AOS Box as long as the antenna inside the box have "clear sight" towards the sky and the satellite. When the indicator turns from green to yellow, this means that the batteries need to be changed, and this must be done before it turns red in order to provide continuous measurements from the site.

Blind plugs must cover the connections in the AOS Box before any transportation, even from the buoy to the barge! These plugs protects the connections from corrosion and electric short circuits.

Batteries in the AOS box must only be changed indoors

Immediately after disconnecting the Doppler cable, replace it with blind plugs. Cable connections must never be exposed to sea water

Keep loose blind plugs in a safe, dry place and make sure that they never disappear during battery changes

7.1 Turn off the AOS box

Before battery change and sending the AOS Box for service or repairs, follow these instructions:

1 Disconnect all sensor cables from the box

2 Replace cables with blind plugs immediately

3 Bring the AOS Box indoors before opening it, wipe off any water sprout before opening it

4 Open the AOS Box and turn it off by using the ON/OFF button in the panel inside the AOS box lid, press and hold it down for 10 seconds.

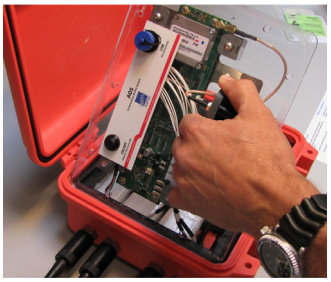
7.2 Change batteries

1 Switch the box OFF as instructed above in chapter 7.1.1

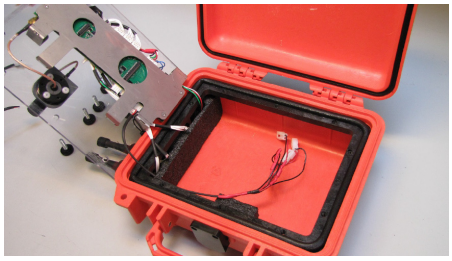
2 Remove all 10 bolts from the panel

Make sure not to loose any of the bolts, keep them in a safe place during the battery change process

3 Flip the panel to the left side and place it leaning steadily on the side of the box. Make sure not to disconnect any cables



4 Remove the batteries, and disconnect the wires from each battery before removing the next

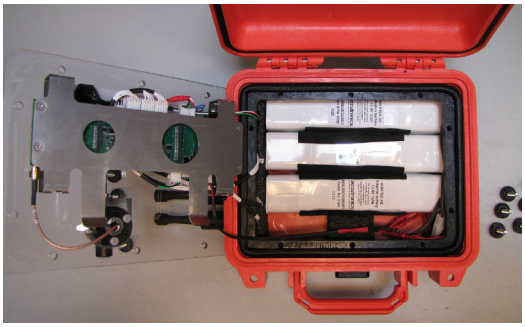


5 Notice how the old batteries are placed in the box and connect the new batteries, one at a time, and place them back into the box the same way the old batteries were placed

! *All batteries must be changed at the same time*

6 Check that all wires are still connected in the panel

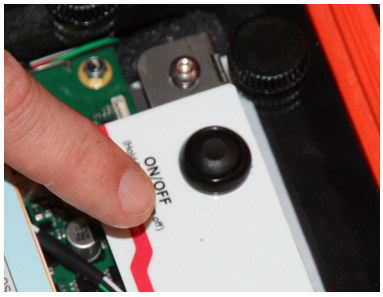
7 Make sure that all contacts in the board are still connected



8 Flip the panel gently back into its place, and make sure that no wires are jammed between the panel lid and the edges of the box

Make sure that no wires lie between batteries and panel, nor between batteries and the case

9 Replace and tighten all 10 bolts and turn the system back on



10 Close AOS Box properly and connect Doppler sensor cable and replace it in the sensor buoy upper chamber as described in chapter 3.1, item 6

Take good care of the blind plugs when they are not connected to the box, and make sure that they are easy to access whenever needed

8 Maintenance

Before connecting cables to AOS Box, we recommend spraying the connections with WD-40 or similar anti corrosive fluids in order to reduce risk of corrosion when keeping it in sea water areas. If AOS Box is taken out from the sensor buoy for service, change of batteries, or for any other reason, always replace cable connections with plug caps immediately after removing cables from the box.

Unnatural variations in measurements from one hour to the next or large variations from day time measurements and night time measurements, may be caused by the batteries in the AOS Box are running out of power. If this is not the case, and the battery indicator still shows green, these variations will most likely indicate fouling on the sensor, and requires immediate cleaning.

Some fouling will generally not affect Doppler measurements, however we recommend cleaning the sensor head at least every three months, for instance whenever the batteries are changed, and more often during the summer season. Be especially careful when cleaning the beam “eyes”, use a soft cloth and warm water to clean these.

Oxygen sensor will not be very affected by fouling. We still recommend cleaning both membrane and remaining parts of the oxygen sensors regularly, for instance once a month, and more often during sprout season (summer and other warm periods).

Salinity sensor may be affected by fouling in the measuring area in the opening in the end of the sensor unit. We recommend cleaning this opening regularly, at least once a month, and more often during sprout season.

Fouling on the cage net will also affect sensor measurements from inside the cage, therefore, regular control of the net with camera in cages where sensors are installed is required. Also, sensors and nets must be controlled more often during warm seasons, because of increased fouling in these periods.

8.1 Cleaning

Cleaning sensors is done carefully with a soft sponge, cloth or brush. A soft toothbrush may be used for both salinity- and oxygen sensors, and will fit the sensor opening in the salinity sensor perfectly.

If the oxygen sensor membrane is damaged by too much or wrongly performed cleaning, the sensor must be sent to Nortek for changing.

Doppler sensor and AOS AKVA Sensor Buoy may be cleaned with normal high pressure water, use not more than 100bar pressure to avoid damages. Avoid washing the green sensor areas in the Doppler head directly with high pressure. The Doppler sensor head may be lubricated with anti-fouling paint to avoid fouling here.

Do not use any sharp cleaning devices when cleaning the sensors, as this may cause irreparable damages

Before actuating net cleaning, all sensors installed inside the cage must be removed from the water, as their cables all are connected to the cage edge and may get twirled into the cleaning device and be destroyed by it.

Remove all sensors from the cage before net cleaning

8.2 Maintenance registration

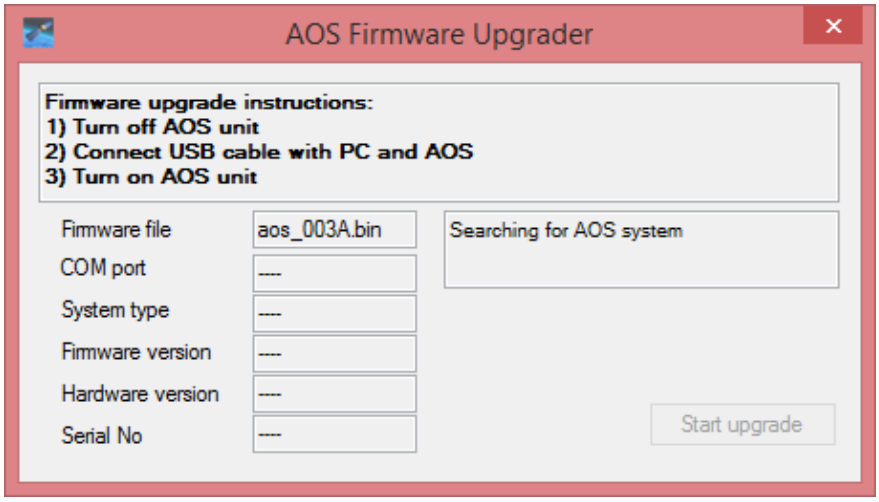
Make copies of this form before filling anything in

Date	Task performed, sensor type and color	Time for next maintenance	Sign.

9 Update AOS Box

In order to use salinity sensors with the AOS Box, the software needs to be updated. This is done by connecting the AOS Box to a PC using the mini USB cable and the USB gate in the panel inside the box.

Contact Nortek to receive access to AOS Firmware Upgrader:



After the upgrade, the box requires configuration. Contact Nortek once again and they will perform this configuration.

Contact information Nortek:

- E-mail: support@nortek.no
- Phone: 67 17 45 00

AOS Box without USB-port in the panel inside the box can not be upgraded to salinity use. These can only measure currents and oxygen.

10 Spare parts for AOS AKVA Sensor Buoy

When ordering spare parts for sensors, use these item numbers:

Sensor	Oxygen	Salinity
Red	**10001601**	**10001604**
Blue	**10001602**	**10001605**
Green	**10001603**	**10001606**

Doppler-sensor is ordered with no.: **10000614**.

When ordering spare sensor cables, use these item numbers:

Cable lengt	Oxygen sensor	Salinity sensor
6m	**10001166**	**10001207**
10m	**10001515**	**10001367**
25m	**10001387**	**10001516**
50m	**10000615**	**10001208**
75m	**10000616**	**10001209**
100m	**10000617**	**10001210**

Both sensors and cables are delivered with plug caps.

Doppler sensor cable 2,5m is ordered with no.: **10000813**.

AOS Box batteries, item no.: **0105891**

New batteries are ordered via the website, see chapter 5.2 for instructions.

Order new blind plugs:

- 5-pin blind plug, item no.: **10001520** (oxygen and salinity)
- 8-pin blind plug, item no.: **10001239** (Doppler sensor)

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Appendix B - Deviation form

Make copies of this form before filling anything in

Deviation control nr.:	

Unit:	**Producer:**	**Prod.no.:**	**Purchase year:**

Deviation description:
Follow up proposition:
Date and signature, declarer:

Follow up directed:
Status:
New action for deviation no.:
Date and signature, follow up:

Appendix C - Notes

Appendix D - Contact information

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